# NCBROWSE: A GRAPHICAL NETCDF FILE BROWSER

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## 1. INTRODUCTION

The netCDF file format and library have been widely adopted by the oceanic and atmospheric communities. The netCDF library provides a machine-independent format for representing array-oriented scientific data (Davis and Fulkner, 1999). NetCDF provides a very flexible and self-describing data format. However, many applications that use netCDF are designed to handle only a small subset of all the possible netCDF conventions.

ncBrowse is a Java application that provides flexible, interactive graphical displays of data and attributes from a wide range of netCDF data file conventions. In this paper, design goals and architecture of ncBrowse and examples using ncBrowse are presented.

## 2. NETCDF FILE BROWSER

ncBrowse enables a user to view the netCDF file schema using a "tree" or "table" presentation. The tree view provides a flexible interface, allowing the user to expand or collapse branches and nodes until only those schema elements (dimensions, global attributes, variables, and variable attributes) of interest are displayed. A user can graphically display subsets from multi-dimensional data arrays using the Scientific Graphics Toolkit (SGT) (Denbo, 1999 and Denbo, 1997).

### 2.1 *Design Goals and Decisions*

The principal requirements that guided the design and development of ncBrowse are:

***Easy to use.*** ncBrowse uses Java Swing components to create a user interface that provides a "natural" navigation through the contents of a netCDF file.

***Platform neutral.*** Using Java and Java netCDF library in the ncBrowse development creates an application that runs on Windows, Unix, and MacOS operating systems. ncBrowse requires Java jdk1.2.x or newer on Windows and Unix. A reduced functionality version, that requires Java jdk1.1.x, is available for MacOS.

***Independence from netCDF conventions.*** In practice, netCDF files are created using one of the published netCDF file conventions, e.g. COARDS or PMEL-EPIC/CTD. While file conventions enable applications to be written more quickly (the myriad of possible ways to store data doesn't have to be addressed) the applications often have difficulty reading generic netCDF files. ncBrowse does recognize some of the conventions, but doesn't require them. For example, an axis variable whose units follow the form "seconds since 1987-02-08 10:00:00 GMT" is recognized as a time axis. ncBrowse also recognizes the variable attributes missing_value, _FillValue, add_offset, and scale_factor.

***Easy to compare netCDF files.*** ncBrowse was designed to allow multiple open netCDF files and graphical displays. The user can easily minimize or maximize windows from the main ncBrowse window (Figure 1).

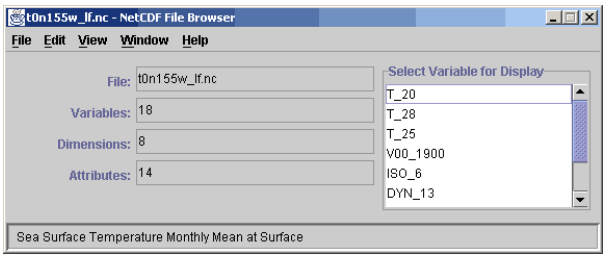


Figure 1. ncBrowse main application interface. The left panel summarizes the number of variables, dimensions, and attributes in the file. The right panel contains a scrolling list of the variables.

### 2.2 *Architecture*

ncBrowse was designed to separate the data model (internal representation of a netCDF file) from the view. A view is a graphical or textual representation of the data. In ncBrowse, views include representations of the file schema - TableView and TreeView, and representations of the data - VariableGraph and VariableText. The main ncBrowse components are indicated in Figure 2.

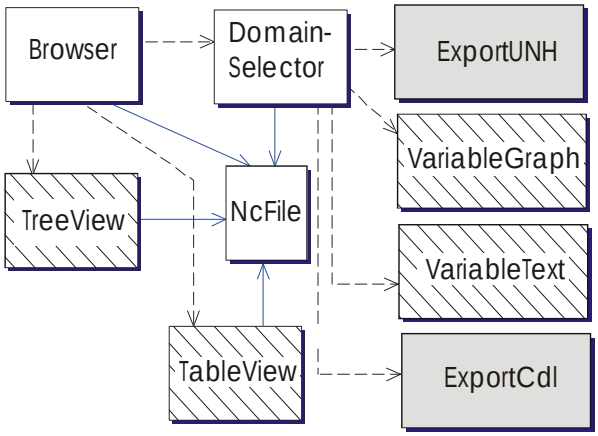


Figure 2. Major components of ncBrowse. The four view classes are indicated by hashed boxes. The export functions by gray boxes. Dashed lines indicate object instantiations, solid lines indicate references to the netCDF file.

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***Browser.*** From the Browser (Figure 1), the main application interface, a user can open a netCDF file in the current Browser or instantiate a new Browser (allowing multiple files open at once), select a view, table or tree, of the file schema, export a variable to an ascii file, manage application windows, and obtain help. A variable can be selected from a list and a right-mouse-click on the selected variable name will launch the DomainSelector.

***DomainSelector.*** The DomainSelector (Figure 3) is

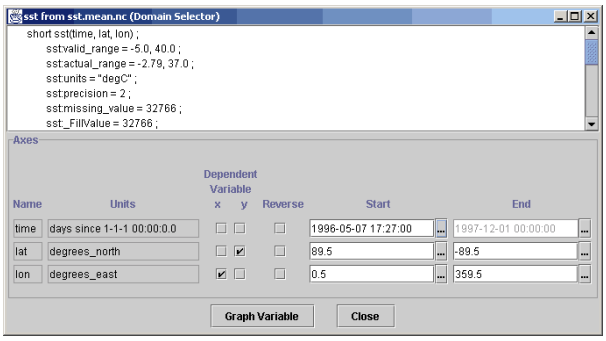


Figure 3. The DomainSelector has been use to select the lon and lat axes as the x and y dependent axes, respectively.

used to map netCDF dimensions, to the x and y graphical axes. If only one dimension is selected a line plot will be created. The DomainSelector can also be used to create a subset of the variable. The range may be adjusted for selected dimensions and a single point chosen for non-selected dimensions. ncBrowse does not currently understand the difference between right- and left-handed coordinate systems, e.g. altitude or depth for the vertical axis, and therefore provides an option to reverse the axis values. Once the axes and their ranges have been selected a user can graphically display the selection by pressing the "Graph Variable" button.

***TableView.*** The TableView is provides a quick look at the netCDF file schema (Figure 4). The length and units

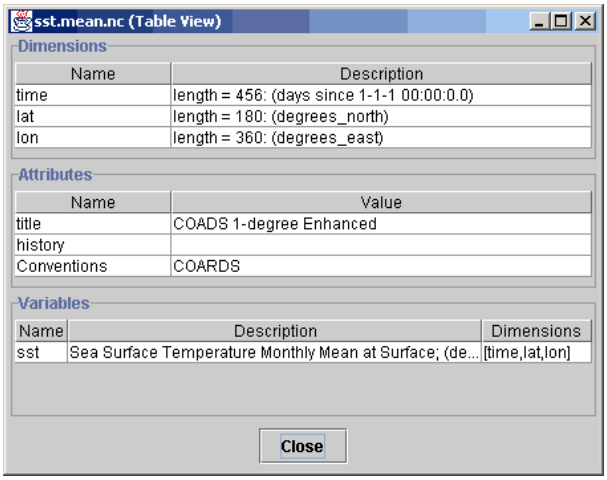


Figure 4. Table view of the file COADS sst.mean.nc.

of dimensions are presented, but no other attributes. All global attributes are listed, but only the first element of an attribute array is displayed. The name, long_name, units, and dimensions are shown for each variable.

***TreeView.*** A complete tree representation of the netCDF file is presented by TreeView using the JTree widget (Figure 5). The main tree branches are dimen-

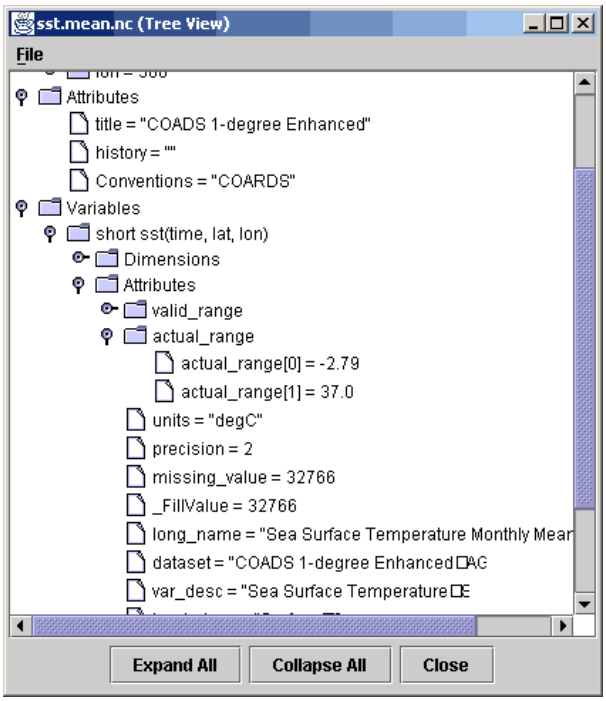


Figure 5. Tree view of the COADS file sst.mean.nc. Both values of the actual_range array are shown.

sions, global attributes, and variables. Dimensions their associated variables and attributes are displayed. Attribute arrays, global or variable, are displayed with a separate leaf for each array value. A right-mouse-click on a variable name will open the DomainSelector for that variable.

## 3. EXAMPLES

Figure 6 displays a latitude - longitude map of sea surface temperature for May 1996 from the COADS (Woodruff et al., 1998) data set. Variable data in the COADS netCDF files are stored as short integers with an offset, scale, and missing data attributes. ncBrowse applies the offset and scaling, and replaces the missing data value with Not-a-Number (NaN) value. SGT tests for NaN values and does not plot them. The graph title is constructed from the file name and the long_name variable attributes. Axis labels are created from the axis name and the associated variable units. The colorbar title combines the variable name with each axis name and a '*' (star) to denote a range or a single value.

A temperature time series from the TAO project (McPhaden et al., 1998) is shown in Figure 7. The TAO project uses the PMEL-EPIC convections for encoding

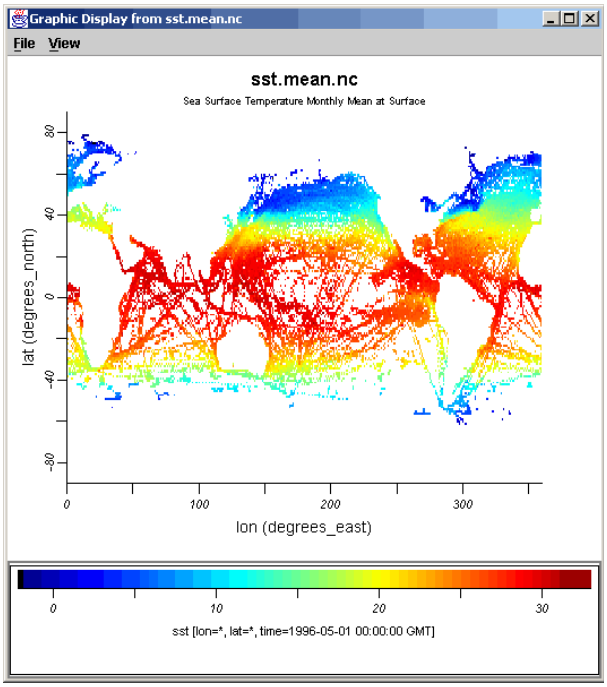


Figure 6. Raster plot of global COADS sea surface temperature for May 1996. White background is indicative of missing data.

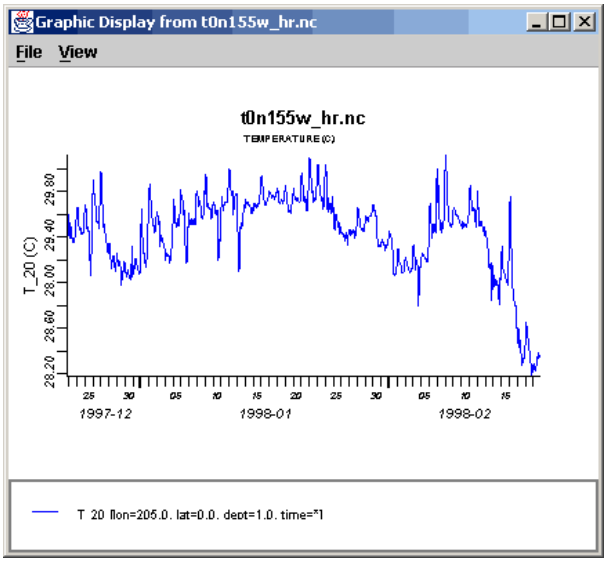


Figure 7. TAO time series of temperature at 1 meter depth, 155W 0N, and from Dec. 24, 1997 through Feb. 19, 1998.

time. The PMEL-EPIC conventions use two integer variables, time and time2, that contain the Julian day number and milliseconds since midnight, respectively. ncBrowse recognizes the PMEL-EPIC time encoding and converts these integers into GeoDate objects. (The GeoDate class extends java.util.Date and has the nice feature that all times are considered UTC [GMT].)

The final example is from the OLEM numerical model (Denbo and Skyllingstad, 1995). A depth-time graph of horizontally averaged east-west current is shown in Figure 8. OLEM encodes time as an integral number of sec-

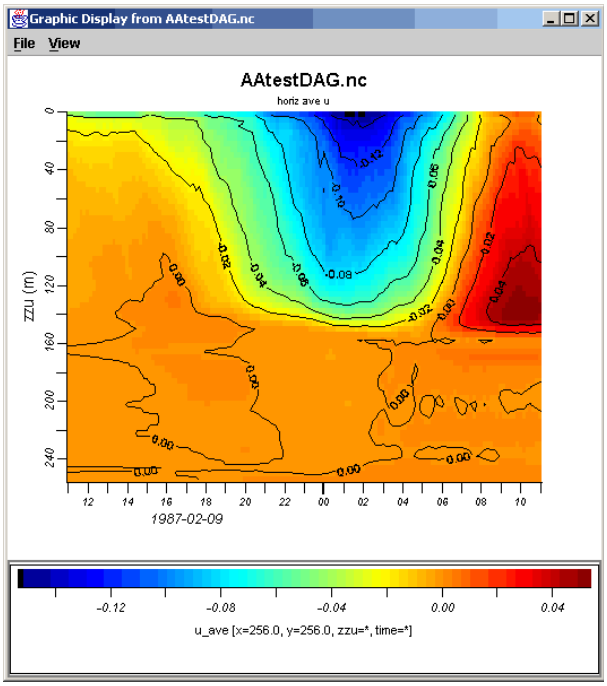


Figure 8. Contour and color fill of horizontal velocity from a model simulation of a strong wind event in the Gulf of Maine during Feb. 9-10, 1987.

onds since a reference date, for example, units of "seconds since 1987-02-08 10:00:00". The depth axis was reversed using the DomainSelector "reverse" option.

## 4. FUTURE DIRECTIONS

ncBrowse is a popular and useful tool for working with netCDF files. Since initial release in late March 2000 through September 2000, ncBrowse has been downloaded at over 530 unique sites and 33 countries. Plans for improvements and additions to ncBrowse over the next few years include:

- Editing of attribute values and variable names.
- Palette control.
  - Set range for colorbar.
  - Use zoomed range of graph for colorbar range.
- Vector plots.
- Support of parametric plots. For example, temperature vs. salinity plots with depth and the parameter.

Improvements to SGT, the Java graphics package, will be incorporated into ncBrowse as they become available and are appropriate.

## 5. AVAILABILITY

More information and download links for ncBrowse and SGT are available at http://www.epic.noaa.gov/java/ncBrowse and http://www.epic.noaa.gov/java/sgt.

The netCDF library (C, C++, Fortran, and Java) is available at http://www.unidata.ucar.edu/packages/netcdf.

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